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Dental age estimation in Egyptian children, comparison between two methods

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ABSTRACT

The need to estimate age of living individuals is becoming increasingly more important in both forensic science and clinical dentistry. The study of the morphological parameters of teeth on dental radiographs of adult humans is more reliable than most other methods for age estimation. Willems and Cameriere methods are newly presented methods. The aim of this work was to evaluate the applicability of using these methods for Egyptian children. Digitalized panoramas taken from 286 Egyptian children (134 boys, 152 girls) with age range from 5 to 16 years were analyzed. The seven left permanent mandibular teeth were evaluated using the two methods. The results of this research showed that dental age estimated by both methods was significantly correlated to real age. However, Willems method was slightly more accurate (98.62%) compared to Cameriere method (98.02%). Therefore, both methods can be recommended for practical application in clinical dentistry and forensic procedures on the Egyptian population.

1. Introduction

Age estimation in children is a fundamental question in forensic medicine, pediatric endocrinology and in orthodontic treatment. The need to evaluate age to consider legal responsibility, or for application of different laws for young people, requires reliable methods. The study of the morphological parameters of teeth and hand/wrist radiographs of children is more reliable than most other methods for age estimation and is most commonly used to determine age in living humans.[1]

Tooth formation is widely used to assess maturity and to predict age. Within clinical dentistry, such information aids in diagnosis and treatment planning.[2] The age range from 9 to 14 years remains the most critical with regard to estimating a child's dental age and consequently, to determine the proper timing for initiating orthodontic therapy.[3]

Dental age estimation using developmental stages of teeth is more useful than using tooth eruption since tooth development is less influenced by environmental factors such as extraction of deciduous predecessors.[4]

Numerous odontological studies have also been carried out to establish age, assessing mineralization within acceptable error limits. The most common method for dental age assessment was first published by Demirjian et al.[5] and since then odontology has carried out numerous studies in this issue.[6]

The Demirjian method has been widely used ever since and it is of special interest both for the orthodontists when planning therapeutical procedures of different kinds of malocclusions as well as in forensic examinations for the dental age determination of living persons and of human remains.[7] To improve this method, several authors developed alternative approaches based on the measurement of some significant tooth parameters, such as crown height, apex width and root length of the teeth observed in radiographs.[8]

Willems et al.,[4] adapted a method for dental age estimation in a Belgian Caucasian population. It is a modification of Demirjian method (new tables for boys and girls with age scores directly expressed in years). The adapted method was validated and resulted in more accurate dental age estimations in this population.

Cameriere et al.,[9] took a completely different approach and published a mathematical formula for calculating dental age on teeth for some European countries. The method is based upon measuring the completeness of apical development via a computer method and all studies to date show a very strong correlation to chronological age.

In the dental literature the existence of different patterns of dental maturation among different populations has been reported

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Table 1
Cross tabulation of age and sex groups.

Age groups	Sex		Total
	Females	Males	
5–6 years	0 (0%)	6 (4.5%)	6 (2.1%)
6–7 years	9 (5.9%)	16 (11.9%)	25 (8.7%)
7–8 years	7 (4.6%)	13 (9.7%)	20 (7%)
8–9 years	29 (19.1%)	8 (6%)	37 (12.9%)
9–10 years	16 (10.5%)	4 (3%)	20 (7%)
10–11 years	26 (17.1%)	24 (17.9%)	50 (17.5%)
11–12 years	8 (5.3%)	6 (4.5%)	14 (4.9%)
12–13 years	3 (2%)	24 (17.9%)	27 (9.4%)
13–14 years	23 (15.1%)	25 (18.7%)	48 (16.8%)
14–15 years	17 (11.2%)	0 (0%)	17 (5.8%)
15–16 years	14 (9.2%)	8 (6%)	22 (7.7%)
Total	152 (100%)	134 (100%)	286 (100%)

and hence, different standards were found in several countries.[10] Since dental age assessment is considered important, the aim of the present study was to evaluate the suitability of using Willems method and Cameriere method standards in a sample of Egyptian children through analysis of panoramic radiographs on teeth.

2. Materials and methods

2.1. Study design

It is a study of panoramic radiographs of patients treated at the Orthodontics Department (from August 2007 till August 2008), Faculty of Dentistry, Mansoura University.

2.2. Sample

Panoramas taken from 286 Egyptian children (134 boys, 152 girls) aged between 5 and 16 years were analyzed (Table 1). Radiographs were digitalized and images were recorded on computer files, which were processed using Microsoft Office Picture Manager and assessed using Image Tool program for digitalized images (UTHSCSA, Texas, USA). The seven left permanent mandibular teeth were evaluated. The inclusion criteria were age between 5 and 16 years at the time the dental panorama was obtained, good quality radiographs, no agenesis or extractions in the left lower quadrant. Exclusion criteria were hypodontia or hyperdontia.

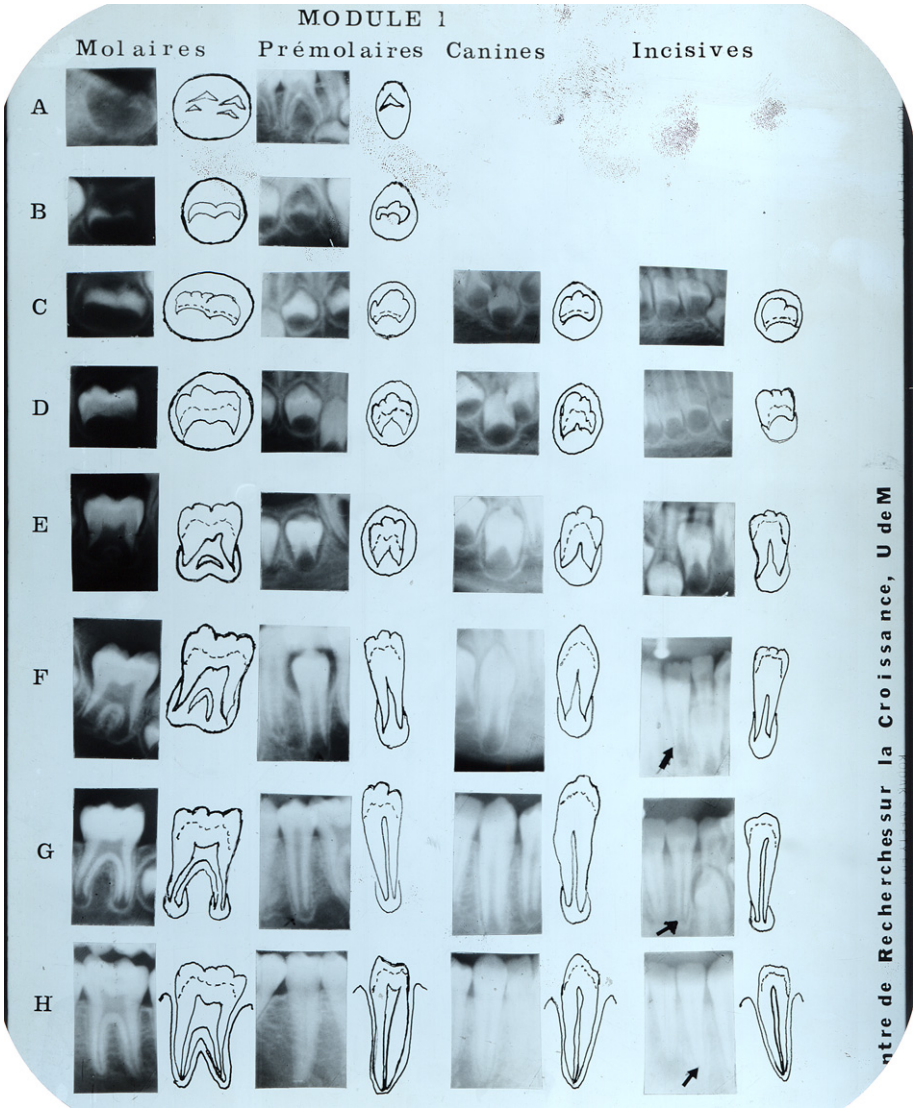

Fig. 1. Assessment of tooth formation stage of left mandibular second molar, first molar, premolars, canine and incisors. The sum of scores from Willem's table is dental age.[4]

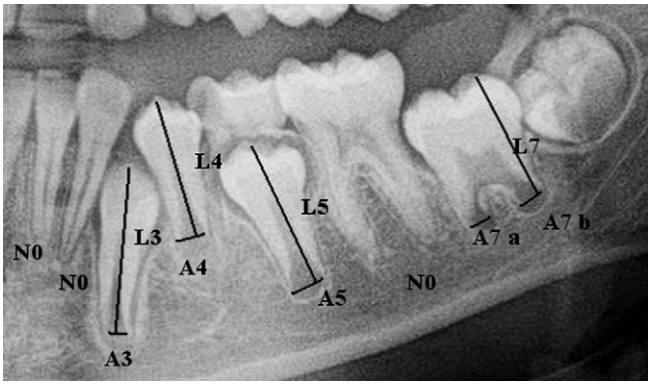

Fig. 2. An example of tooth measurement. *A*, is the distance between the inner sides of the open apex, *L* is the length of the seven teeth and *N*0 is a tooth with closed root.

2.3. Dental age methods

2.3.1. Willems method

Each tooth on the left side of the mandible (except the third molar) is given a letter from A to H depending on its developmental criteria (Fig. 1). Each letter corresponds to a score. Maturity scores were converted into fractions of dental age using published conversion tables and then these were summed to obtain dental age. Different standards are used for boys and girls.[4]

2.3.2. Cameriere method

According to Cameriere et al.,[9] the following linear regression formula was used:

$$\text{Age} = 8.971 + 0.375 \times g + 1.631 \times 5 + 0.674\text{N0} - 1.034s - 0.176s \times \text{N0}$$

where (*N*0), is the teeth with the apical ends of the roots completely closed. While (*s*) is the sum of *A*/*L* ratio for every tooth with open apex or apices. (*A*) is the radiographic distance between the inner sides of the open apex for single rooted teeth. For teeth with two roots, the sum of the radiographic distances between the inner sides of the two open apices was calculated. (*L*) is the radiographic tooth length (Fig. 2). *A*/*L* ratios were considered to take into account the effect of possible differences in magnification and angulations among radiographs. The "5" in the formula is the *A*/*L* ratio of tooth 5. Meanwhile, (*g*) is a variable equal to 1 for boys and 0 for girls. All the morphological variables and subjects' gender were entered in an EXCEL file.

Chronological age, calculated by subtracting date of birth from the date of radiograph, was also recorded in the EXCEL file.

2.4. Calculating accuracy

Dental age for each method was compared with chronological (real) age for each subject. The chronological age was subtracted from the dental age, and a positive result indicates an overestimation and negative figure an underestimation. Dental age estimation was carried out by two well-trained observers.

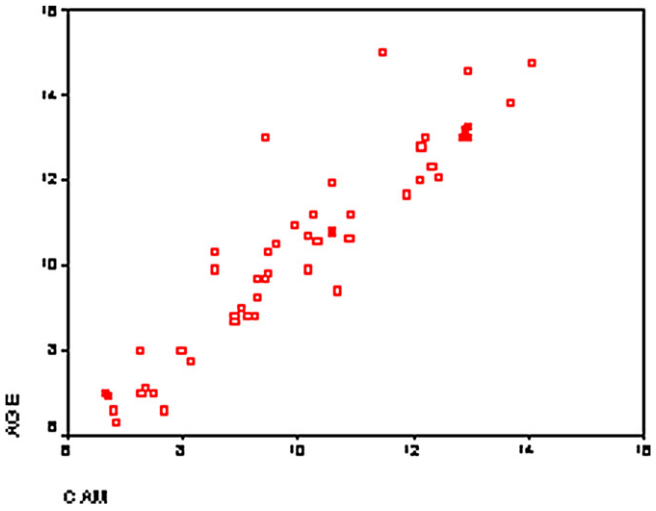

Fig. 3. Shows correlation between ages estimated by Cameriere method and chronological age in total sample ($p < 0.001$).

A random sample of 50 panoramic radiographs was re-examined after 2 weeks for intra-observer reproducibility.

Statistical analysis was performed with SPSS version 11.0 statistical program. Chronological age and both estimates of dental age were described by frequency distribution, means and standard deviation. Correlation between chronological age and dental age was examined by Pearson correlation coefficient. The percentage of error was calculated by dividing the difference between the chronological age and dental age by the chronological age. The percentage of accuracy (100 − percentage of error) was also evaluated.

3. Results

Cross tabulation of age and sex groups is demonstrated in Table 1. The results of this research showed that, age of the collected sample ranged from 5 years and 10 months (5.83 years) to 15 years and 9 months (15.75 years) (Table 2).

Intra- and inter-observer reliability as assessed by reliability Alpha (Cronbach) were 0.91 and 0.985, respectively. A significant positive correlation ($p < 0.001$) between ages estimated by both methods and chronological age was found for the total sample and in both sexes (Figs. 3 and 4).

In relation to real age, the estimated age by Willems method showed an average overestimation of age by 0.15 ± 0.62 years for the total sample, 0.14 ± 0.74 years for girls and 0.29 ± 0.48 years for boys. While that by Cameriere method showed an average underestimation by -0.29 ± 1.04 years for the total sample, -0.26 ± 1.21 years for girls and -0.49 ± 1.03 years for boys.

Percentage of accuracy (100 − percentage of error) showed that Willems method is 98.62% and Cameriere method is 98.02% accurate.

4. Discussion

Tooth formation has been more widely used than tooth eruption for assessing dental maturation because it is a continuous and

Table 2
Mean and standard deviation of chronological age and ages estimated by both methods.

		Total (boys and girls)	Girls	Boys
Chronological Age	Range (Mean ± SD)	5.83–15.75 (10.82 ± 2.75)	6.33–15.67 (11.04 ± 2.69)	5.83–15.75 (10.56 ± 2.79)
Dental age (Willems method)	Range (mean ± SD)	6.41–16.03 (10.97 ± 2.65)	6.94–15.79 (11.1 ± 2.56)	6.41–16.03 (10.83 ± 2.75)
Dental age (Cameriere method)	Range (mean ± SD)	6.64–14.06 (10.39 ± 2.14)	6.68–14.06 (10. 39 ± 2.05)	6.64–14.06 (10.39 ± 2.24)

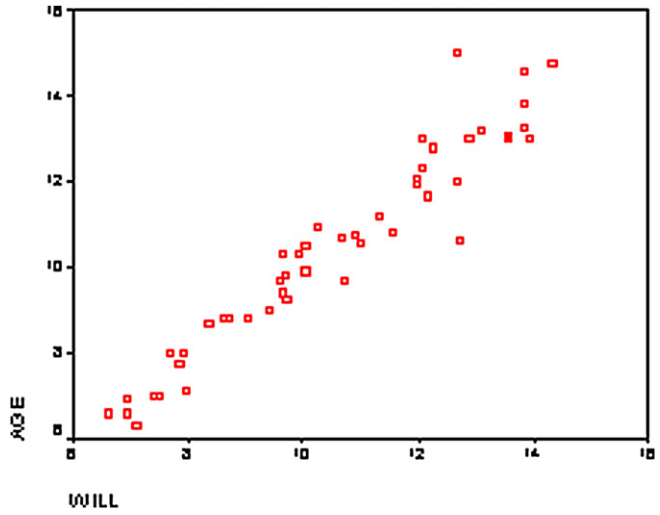

Fig. 4. Shows correlation between ages estimated by Willems method and chronological age in total sample ($p < 0.001$).

progressive process that can be followed radio-graphically and most teeth can be evaluated at each examination.[10] Morphological measurements can be reliably made in panoramic radiography, provided that some corrections are made to take into account the individual variability of tooth size and the differences in magnification of radiographs and angulation between X-ray beam and film.[9]

It has been reported that development of each individual can be affected by genetic, racial, nutritional, climate, hormonal and environmental factors.[11] Hence, considering the regional difference in country region like Egypt, would be very significant.

The results obtained in our study on both boys and girls showed a high correlation between the real (chronological age) and the age estimated by both Willems and Cameriere methods.

Age estimation in the present studied sample as evaluated by Willems method yielded an average overestimation of age by 0.14 years for girls and 0.29 years for boys being better in girls. This confirms previous results in Belgian Caucasian,[4] Indian[12] and in Malay populations.[13] However, in Belgian Caucasian and in Indian populations, Willems method showed better accuracy for boys than girls. Difference in accuracy between boys and girls may be due to faster development in girls[7] or as Rai[14] proposed due to geographical causes.

Although other authers,[15] confirmed an overestimation of age by Willems method in boys, they observed an underestimation of age in girls. But in Bangladeshi and British Caucasian population, Willems method underestimated age by an average 0.05 years for boys and 0.2 years for girls with no significant differences being observed between both ethnic groups.[16] This controversy may be due to difference in genetic, environmental, nutritional and geographical factors.[17]

In the present study, age estimation by Cameriere method resulted in an average underestimation of age by 0.26 years for girls and 0.49 years for boys. Similar to the present results, Cameriere method resulted in underestimation of age in different European populations. Cameriere et al.[18] tested this method on Italian, Kosovan and Slovenian children resulting in residual standard error of estimate being 0.89 years. Cameriere method yielded more accuracy in girls versus boys.[15]

A larger study on European populations: Croatia, Germany, Kosovo, Italy, Slovenia, Spain, and UK, was conducted.[19] The results of this study showed that the median of the absolute value of residual errors between actual and estimated ages was 0.035 years that did not differ between these populations. In Italian population, Cameriere and Ferrante[1] improved the regression formula proposed by Cameriere et al.[9] and pointed out that the regression lines for both boys and girls were parallel, but the estimated ages for girl were 0.401 years below that of boys.

Meanwhile in Indian population, Cameriere method yielded a mean overestimation of 0.05 years for boys and 0.04 years for girls.[12] This led Rai et al.[20] to propose a specific formula for Indians. In Peruvian school children, Cameriere method yielded more accurate estimates compared to the Demirjian method with the mean error in age estimation being 0.75 years.[21]

Egyptian as many European populations are all Caucasians and share more or less the same geographical characters (especially those around the Mediterranean Sea). This may explain the high correlation between estimated age by Cameriere method and real age in the studied Egyptian sample.

Although numerous factors may affect comparison between different methods for dental age estimation, ethnicity, social status,[20] sample size and statistical approach[7] may explain the different results obtained in different populations.

Although accurate, Cameriere method involves more steps during calculation and more training for observers is needed. The results of this research highlighted the fact that, Willems method is more accurate than Cameriere method. Applying the European formula on a small sample of the Egyptian population may explain these results. This confirms previous study on Indian population[12] which showed that Willems method was more accurate than Cameriere method. However, it is contradictory to others,[15] who concluded that Cameriere method was more accurate than Willems method in European population.

Based on the results of this research, it can be concluded that both Willems and Cameriere methods are suitable for dental age estimation in Egyptian children, however, Willems method was slightly more accurate when applied on this sample of Egyptian population. Therefore, both methods can be recommended for practical application in clinical dentistry and forensic procedures on the Egyptian population.

Conflict of interest statement

Neither the author or any of the coauthors have any potential conflict of interests related to the publication of this paper.

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Ethical approval

This study was conducted in Mansoura University, Egypt and approved by local ethical committee.

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